Review

Aonla (*Emblica officinalis*): a wonderful berry with therapeutic effects

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ABSTRACT

Emblica officinalis Gaertn or *Phyllanthus emblica* Linn, commonly known as Indian gooseberry or aonla, is perhaps the most important medicinal plant in the Indian traditional system of medicine, the Ayurveda. Several parts of the plant are used to treat a variety of diseases but the most important is the fruit. Many ailments are treated using the fruit which is used either alone or in combination with other plants. These include common cold and fever, as a diuretic, laxative, liver tonic, refrigerant, stomachic, restorative, alterative, anti-pyretic, anti-inflammatory, hair tonic; to prevent peptic ulcer and dyspepsia. *E officinalis* possesses anti-pyretic, analgesic, anti-tussive, anti-atherogenic, adaptogenic, cardioprotective, gastroprotective, anti-anemic, anti-hypercholesterolemic, wound healing, anti-diarrheal, anti-atherosclerotic, hepatoprotective, nephroprotective and neuroprotective properties as demonstrated in numerous preclinical studies. Furthermore, experimental studies have reported that *E officinalis* and some of its phytochemicals also exhibit anti-carcinogenic properties. It is also reported to possess radiomodulatory, chemomodulatory, chemopreventive, free radical scavenging, anti-oxidant, anti-inflammatory, anti-mutagenic and immune-modulatory activities. These properties are efficacious in the treatment and prevention of cancer. This review summarizes the sudies related to these properties and also emphasizes the aspects that warrant future research establishing its activity and utility as a cancer preventive and therapeutic drug in humans.

Keywords: Aonla; properties; therapeutic applications; fruit

INTRODUCTION

Emblica officinalis Linn (Euphorbiaceae), commonly known as Indian gooseberry, is perhaps the most important medicinal plant in the Indian traditional system of medicine and is believed to increase defense against diseases. It is used equally as a medicine and as a tonic to build up lost energy and vigour. Aonla is a natural, efficacious anti-oxidant with the richest source of vitamin C (200-900 mg/100 g of edible portion). Many ailments are treated using the fruit which is used either alone or in combination with other plants. These include common cold and fever, as a diuretic, laxative, liver tonic, refrigerant, stomachic, restrorative, alterative anti-pyretic, anti-inflammatory, hair tonic, to prevent peptic ulcer and dyspepsia and as a digestive. Aonla possesses anti-pyretic, analgesic, anti-tussive, anti-diabetic, anti-atherogenic, adapto-genic, cardio-protective, gastroprotective, anti-anemic, anti-hyper-cholesterolemic, wound healing, anti-diarrheal, hepato-protective, nephro-protective and neuro-protective properties as demonstrated in numerous preclinical studies (Krishanveni and Mirunalini 2010). It has anti-viral properties and also functions as an anti-bacterial and anti-fungal agent. The gelatinous plum-sized aonla fruit contains naturally occurring vitamin, heat stable vitamin C. Vitamin C contained in it is better assimilated than synthetic vitamin C. It is reported to contain nearly 20 times as much vitamin C as orange juice. The edible fruit tissue has 160 times the ascorbic acid concentration of an apple. The fruit also contains higher concentration of most minerals and amino acids than apple. Aonla fruit ash contains chromium, zinc and copper. It is considered as adaptogenic that improves immunity. The taste of Indian gooseberry is sour, bitter and astringent.

Origin and distribution

E officianilis has been grown and recognized in India earlier than 3,500 years. Sushruta, the father of ancient medicines (1500-1300 BC), mentioned about the effect of *E officinalis* used in Ayurvedic

preparations. It can survive in various kinds of land such as arid, semi-arid, salt-affected, coastal and valleys. It is one of the important native fruits of Indian subcontinent. Naturally growing trees of aonla have been reported from India, Sri Lanka, Java, West Indies, Trinidad, Hawaii, Florida, Iran, Malaya and China and Panama Canal regions. It is commonly grown all over tropical and subtropical parts of India. The major concentration of aonla cultivation is in Pratapgarh district of Uttar Pradesh and some pockets of Gujarat. Aonla has spread over 50,000 ha area in the country with approximate production of 1,75,000 tonnes.

Botanical characteristics (description of the plant)

E officianilis is a small to medium size tree with a crooked trunk, spreading branches and grayish-green bark that peels off in flakes. The branchlets are glabrous or finely pubescent, 10-20 cm long, usually deciduous with the leaves simple, sub-sessile and closely set along the branchlets. The leaves are light green resembling pinnate leaves. The flowers are greenish yellow born in axillary fascicle. The fruits are depressed, globose in shape, 1-2.5 cm in diameter, fleshy and six-lobed containing trigonous seeds. They are green when unripe and turn light yellow or brick red when mature. The seeds are acrid and sweet with aphrodisiac and anti-pyretic properties. Seeds are obovate, triangular, three-celled and two seeds in each cell. They yield about 16 per cent of brownish yellow oil containing 44 per cent linoleic acid, 28.4 per cent oleic acid, 4.8 per cent linolenic acid, 2.2 per cent stearic acid and 3.0 per cent palmitic acid. The seed weight is about 570 g/1,000 seeds. The seed oil resembles linseed oil.

Traditional uses: Siddha, Unani, Tibetan and Chinese systems of medicine utilize *E officianilis*. In traditional Indian medicine, dried and fresh fruits of the plant are used. All parts of the plant are used in various Siddha, Unani, Tibetan and Chinese systems of medicine including the fruits, seeds, leaves, roots, bark and flowers. According to Ayuerveda, aonla fruit is sour and astringent in taste with sweet, bitter and pungent secondary taste. It also balances both Pitta and Vata and Kapha by virtue of its sweet taste and drying action. Its post-digestive effect is sweet and its energy is cooling. It is considered to be a powerful Rasayana and useful in delaying the degenerative as well as senescence process. It helps to increase longevity, improve digestion and treat constipation. It also reduces fever, purifies the blood, reduces cough, strengthens the heart, alleviates the asthma, stimulates the hair growth and invigorates the body as per the Ayuervedic system of medicine (Baliga and Dsouza 2011).

Culinary use: The fruit is commonly pickled with salt, oil and spices. The aonla fruit is eaten raw or cooked into various dishes. Its tender varieties are used to prepare dal, Murabbah, beverage, candy, Churan, juice, jam, mouth freshener, shred, squash etc.

Other uses: It is popularly used in inks, shampoos and hair oils; the high tannin content of Indian gooseberry fruit serves as a mordant for fixing dyes in fabrics. Aonla shampoo and hair oil are traditionally believed to nourish the hair and scalp and prevent premature hair growth.

Phytochemistry: *E officinalis* is one of the most extensively studied plants. It contains tannins, alkaloids and phenolic compounds. The fruits contain higher amount of vitamin C and considerably higher concentration of most minerals, proteins and amino acids like glutamic acid, proline, aspartic acid, alanine, cystine and lysine. Vitamin C level is more than that in oranges. It contains higher amount of hydrolysable tannins like emblican A and B, punigluconin and pedunculagin. Phytochemical investigation revealed that it contains higher amount of flavonoid like quercetin. Fruits were also analyzed for their alakaloidal content viz phyllantidine and phyllantine. The fruit also contains gallic acid, ellagic acid, chebulinic acid and chebulagic acid.

Potential therapeutic properties

Cardio-protective: The main etiologic factor in atherogenesis is ox-LDL and anti-oxidants are accepted as effective treatment of atherosclerosis. Regularization of hyprerglycemia, hyperlipidemia and oxidative stress are important in averting diabetes-induced cardiac dysfunction. The effect of the fruit juice obtained from aonla on myocardial dysfunction in diabetic rats was explored by Patel and Goyal (2010). Treatment with the fruit juice not only prevented the streptpozotocin-induced loss of body weight, increase in water and food intake, increase in serum glucose levels and disturbed lipid profile but also an increase in serum LDH and creatinine, kinase-MB levels, increased myocardial hypertrophy and cardiomypathy. The hemodynamic and left ventricular functions were restored by pre-treatment with *E officinalis*. Significant

preservation of anti-oxidant, myocytes injury-specific marker enzymes and significant inhibition of lipid peroxidation was also observed. Furthermore, histo-pathological salvage of the myocardium reconfined the protective effects of *E officinalis* (Patel and Goyal 2012)

Metabolic syndrome: The ethyl acetate extract of *E officinalis* ameliorated the high fructose-induced metabolic syndrome including hypertri-acyglycerolaemia and hyper-cholesterolaemia. These findings suggested that fructose-induced metabolic syndrome is attenuated by polyphenol-rich fraction of *E officinalis* (Kim et al 2010).

Hypolipidemic: A scientific scrutiny should be undertaken to corroborate the recent evidence that certain medicinal plants possess hypoglycemia, lipid lowering and immune modulating properties on account of their rich flavanoids and other glucose lowering active constituents (Dwivedi and Aggarwal 2009). The lipid levels such as cholesterol and triglycerides in serum as well as liver were markedly elevated in aged rats. The lipid lowering and anti-atherosclerotic effects of aonla fresh juice were evaluated in cholesterol fed rabbits (rendered hyperlipidemic by atherogenic diet and cholesterol feeding). Aonla fresh juice was administered at a dose of 5 ml/kg body weight per day for sixty days. Serum, cholesterol, triglycerides, phospholipids and low density lipoprotein levels were lowered by 82, 62, 77 and 90 per cent respectively.

Gastroprotective: Aonla, besides its food value can be used as a gastroprotective agent in non-steroidal anti-inflammatory drug induced gastropathy. It has been suggested that the anti-oxidative property of aonla is the key to its therapeutic effect (Chatterjee et al 2011). Ulcers were induced by aspirin, ethanol, cold resistant stress and pyloric ligation and chronic gastric ulcers induced by acetic acid in rats. Aonla showed dose dependent ulcer protective effects in the entire above acute ulcer models besides a significant ulcer healing effect after 5-10 days of treatment. The results showed that aonla had a significant ulcer protective as well as healing effect which might be due to its effect both on offensive and defensive mucosal factors (Sairam et al 2002).

Analgesic, anti-pyretic and anti-inflammatory: Many plant derived compounds showed anti-inflammatory effects. Hence they signify prospective molecules for the development of new drugs, particularly designed for the treatment of chronic inflammatory such as rheumatism, asthma, asthma, inflammatory bowel diseases etc (Calixto et al 2004).

Anti-oxidant: Poltanov et al (2009) investigated the chemistry and anti-oxidant properties of *E officianilis* fruit extracts. Extract produced positive responses in the total phenol, total flavanoids and total tannin assays (Devasagayam et al 2004).

Nephro-protective: Yokozawa et al (2007) investigated the effects of *E officinalis* on renal dysfunction involved in oxidative stress during the aging process. The raised level of serum creatinine and urea nitrogen in the aged rats was decreased following the administration of aonla extract. Furthermore, the tail arterial blood pressure was significantly diminished. Thiobarbituric acid reactive substance levels of serum, renal homogenate and mitochondria in aged rats too were considerably reduced by the extract suggesting that aonla would ameliorate oxidative stress due to aging. The increases of inducible nitric oxide synthase (iNOS) and cyclooxygenase (COX) 2 expressions in the aorta of aging rats were also significantly suppressed (Chen et al 2009).

Anti-cancer: Natural products of plant origin currently constitute a considerable proportion of commercially available anti-neoplastic drugs (Shynu et al 2011). Polyphenols act on multiple targets in pathways and mechanisms related to carcinogenesis, tumor cell proliferation and death, inflammation, metastatic spread, angiogenesis or drug and radiation resistance (Asensi et al 2011). Chemoprevention with food phytochemicals is meanwhile regarded as one of the most important strategies for cancer control. *E officinalis* indigenous to India is valued for its unique tannins and flavanoids which contain very powerful anti-oxidant properties. Aonla is a medicinal fruit used in many Asian traditional medicine systems for the treatment of various diseases, including cancer. The aonla extract at 50-100 microns/ml significantly inhibited cell growth of six human cancer cell lines, A549 (lung), HepG2 (liver), HeLa (cervical), MDA MB 231 (breast), SK OV3 (ovarian) and SW620 (colorectal). However the extract was not toxic against MRC 5 (normal lung fibroblast). These results suggest that aonla exhibits anti-cancer activity against selected cancer cells thus warrants further study as a possible chemopreventive and anti-invasive agent (Ngamkitidechakul et al 2010).

Anti-microbial: Infectious diseases are a major reason of morbidity and mortality globally. It accounts for roughly 50 per cent of all deaths in tropical countries and as much as 20 per cent deaths in the America. Notwithstanding the noteworthy advancement made in microbiology in addition to the control of microorganisms, intermittent occurrences of epidemics due to drug resistant microorganisms and previously unknown disease causing microbes pose a huge risk to public health. These adverse health developments demand a universal initiative for the development of novel approaches for the prevention and treatment of infectious diseases. For over 100 years, chemical compounds isolated from medicinal plants have served as the models for many clinically proven drugs and are now being re-assessed as anti-microbial agents. The explanations for this revival include a decrease in the new anti-bacterial drugs in the pharmaceutical pipeline, a proliferation in anti-microbial resistance and the necessity of treatments for new evolving pathogens. Factually thousands of plant species have been tried against hundreds of bacterial strains in vitro and many medicinal plants are active against a wide range of gram-positive as well as gram-negative bacteria (Mahady 2005).

Dermoprotective: Clinical and laboratory studies have identified the benefits of an array of natural ingredients for skin care over the last 20 years. Consequently a number of these ingredients and compounds are today being developed, used or considered not only for anti-aging effects but also for use in dermatologic disorders (Fowler et al 2010, Reuter et al 2010). *E officinalis* extract is known to provide protection for human dermal fibroblasts against oxidative stress due to its potent anti-oxidant properties. Hence it is supposed to be beneficial for natural skin care. Fujii et al (2008) demonstrated that aonla extract stimulated proliferation of fibroblasts in a concentration dependent manner. Besides it also induced production of procollagen in a concentration and time dependent manner.

Diabetic and related problems: Diabetic cataracts are caused by an elevation of polyols within the lens of the eye catalyzed by the enzyme aldose reductase (AR) (Head 2001). AR has been a drug target because of its involvement in the development of secondary complications of diabetes including cataract. Clinically, synthetic AR inhibitors (ARIs) have not been very successful although numerous synthetic ARIs have been tested and shown to inhibit the enzyme. Therefore evaluating natural sources for ARI potential may lead to the development of safer and more effective agents against diabetic complications. Suryanarayana et al (2004) assessed the inhibition of AR by constituents of aonla both in vitro and in lens organ culture. Aonla extract inhibited rat lens as well as recombinant human AR with IC50 values 0.72 and 0.88 mg/ml respectively. Furthermore, the isolated tannoids not only prevented the AR activation in rat lens organ culture but also sugar induced osmotic changes. These results indicate that tannoids of aonla are potent inhibitors of AR and suggest that exploring the therapeutic value of natural ingredients that people can incorporate into everyday life may be an effective approach in the management of diabetic complications (Suryanaryana et al 2004).

Boosts liver health: Drinking aonla juice, as per Ayurveda, boosts vitality and vigor and the underlying reason for it is probably linked to its ability to re-energize the liver. Liver health is not paid much attention to, even though it affects a large part of the population. A study on the hepatoprotective properties of the Indian gooseberry showed that the fruit was effective in preventing the toxic effects of excessive medication and toxic metals. The presence of phytochemicals such as quercetin, gallic acid, corilagin, and ellagic acid in aonla helps in free radical scavenging and in turn detoxifying the body (Muriel and Rivera Espinoza 2008).

Aids in digestion: Aonla is very high in fiber, like most fruits. Fiber adds bulk to the stool and helps move food through the bowels and keeps bowel movements regular. This reduces the chances of constipation. Soluble fiber (found in many fruits) can also bulk up loose stools and reduce diarrhea. Aonla also stimulates the secretion of gastric and digestive juices, so food is digested efficiently, nutrients are absorbed in an optimal way and one feels lighter and healthier (El-Desouky et al 2008). Aonla and aonla powder help in retaining water. This property helps reduce constipation and can help protect from various gastrointestinal disorders and even has implications for colorectal cancer.

Helps the urinary system: Because it enhances all the 13 Agnis (digestive fires) and supports Apana Vata, aonla berry is especially supportive to the urinary system and can be helpful if there is a mild burning sensation while urinating. It supports natural diuretic action but does not force water from the body like diuretic pills. In other words, it helps to eliminate waste from the

body but does not over-stimulate the urinary system (Kumar et al 2012a).

Nourishes the brain and mental functioning: Aonla berry is good for the brain. It is Medhya nurturing for the mind and enhancing coordination among Dhi (acquisition), Dhriti (retention) and Smriti (recall). It helps sharpen the intellect and mental functioning. It supports the nervous system and strengthens the senses (Reddy et al 2011, Vasudevan and Parle 2007).

Diarrhea: It is used medicinally for the treatment of diarrhea. As a fruit decoction, it is mixed with sour milk and given by the natives in cases of dysentery. A decoction and evaporation of the root solution produces an astringent extract equal to catechu. An infusion of the leaves with fenugreek seed is given for chronic diarrhea (Singh et al 2011).

Improves metabolic activity: Eating foods that are high in protein, like aonla, is one of the most important ways to stay healthy. Protein is necessary for cellular growth, muscle development, organ health and a wide range of metabolic activities that we need to remain healthy. Our enzymes can break down plant proteins into amino acids and reassemble them into usable proteins for our body.

Dental problems: The roots of aonla (10 g) are grinded and taken twice daily after taking food. Alternatively the leaves of aonla are squeezed and the juice is extracted. This juice is put in the ear (a few drops) to find relief from a toothache. A final alternative is to grind the node of an aonla and mixing it with water. After vigorous stirring it is filtered through a cloth. This water is put drop by drop in the right ear if the teeth on the left hand side are in pain and vice versa. The remedy is continued for 3 days (Kumar et al 2012b).

Osteoporosis: Osteoclasts (OCs) are involved in rheumatoid arthritis and in numerous pathologies associated with bone loss. Various workers support the notion that certain medicinal plants as well as derived natural products are of great interest for developing therapeutic approaches against bone disorders including rheumatoid arthritis and osteoporosis. Penolazzi et al (2008) determined whether extracts of aonla fruits exhibit activity of probable interest for the treatment of rheumatoid arthritis and osteoporosis by triggering programmed cell death of human primary osteoclasts. Extracts of aonla were able to induce programmed cell death of mature OCs without modifying the process of osteoclastogenesis. Induction of apoptosis of osteoclasts could be an important strategy both in interfering with rheumatoid arthritis complications of the bone skeleton leading to joint destruction as well as preventing and reducing osteoporosis (Penolazzi et al 2008).

Enhances food absorption and balances stomach acids: The regular use of aonla berry can strengthen digestion, absorption and assimilation of food. People taking it notice that they enjoy the taste of food better. It enhances all thirteen digestive fires (Agni). However it works more slowly and gently than ginger or other digestion-enhancing herbs so it can be taken by people with a lot of Pitta without fear of creating excess stomach acid. In addition, it improves assimilation of iron for healthy blood. It also improves digestion but does not heat the body; aonla berry is ideal for calming mild to moderate hyperacidity and other Pitta-related digestive problems (Singh et al 2011).

Scurvy: As an extremely rich source of vitamin C, Indian gooseberry is one of the best remedy for scurvy. Powder of the dry herb, mixed with an equal quantity of sugar can be taken in doses of one teaspoon, thrice daily with milk (Kumar et al 2012b).

Anemia: Aonla is rich in vitamin C or ascorbic acid, an essential ingredient that helps in the absorption of iron. Supplements of aonla can be very beneficial to patients suffering from iron deficiency, anemia etc (Kumar et al 2012b).

Mouth ulcers: A decoction of the leaves is used as a chemical-free bactericidal mouthwash. Bark of the root mixed with honey is applied to inflammations of the mouth and a decoction of the leaves is also useful as a mouthwash in the treatment of aphthae. Another remedy suggests root bark rubbed with honey is used in aphthous stomatitis (an inflammation of the mouth) (Kumar et al 2012b).

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